AMENDMENTS TO THE CLAIMS:

Claims 1-20 (cancelled)

21. (Currently Amended) A method of performing a surface treatment on a surface of a substrate, the surface treatment being selected from the group consisting of coating, denaturation, modification and etching, said method comprising:

bringing a surface treatment gas into contact with a surface of a substrate; and

while bringing said surface treatment gas into contact with said surface of said substrate, irradiating said surface of said substrate with a fast particle beam, other than an electron beam and a neutral beam, to enhance activity of said surface and/or said surface treatment gas so as to facilitate a reaction between said surface and said surface treatment gas.

22. (Previously Presented) The method according to claim 21, wherein

irradiating said surface of said substrate with a fast particle beam comprises irradiating said surface of said substrate with a particle beam selected from the group consisting of a charged particle beam, an atomic beam and a molecular beam.

23. (Previously Presented) The method according to claim 22, wherein the surface treatment is coating of said surface of said substrate, and wherein

irradiating said surface of said substrate with a particle beam selected from the group consisting of a charged particle beam, an atomic beam and a molecular beam comprises irradiating a portion of said surface of said substrate with said particle beam selected from the group consisting of said charged particle beam, said atomic beam and said molecular beam prior to, simultaneously with, and/or subsequent to bringing said surface treatment gas into contact with said surface of said substrate,

such that bringing said surface treatment gas into contact with said surface of said substrate and irradiating said portion of said surface of said substrate with said particle beam results in component elements of said surface treatment gas being chemically deposited onto said surface of said substrate.

Claim 24 (cancelled)

25. (Currently Amended) The method according to claim ~~24~~ 54, wherein

irradiating a portion of said surface of said silicon substrate with said fast particle beam comprises irradiating said portion of said surface of said silicon substrate with a particle beam having a particle energy in a range of from 200 eV to 10 keV.

26. (Previously Presented) The method according to claim 21, wherein the surface treatment is coating of said surface of said substrate, with said substrate including an interlayer insulative film layer as a top layer, wherein

bringing a surface treatment gas into contact with a surface of a substrate comprises bringing into contact with a surface of said interlayer insulative film layer a surface treatment gas including component elements such that a diffusion barrier layer is formed in contact with said interlayer insulative film layer, and

irradiating said surface of said substrate with a fast particle beam comprises irradiating said diffusion barrier layer with said fast particle beam so as to form a strongly combined layer resulting from mixed atoms or molecules of said interlayer insulative film layer and said diffusion barrier layer.

27. (Previously Presented) The method according to claim 26, wherein said interlayer insulative film layer comprises a material consisting essentially of an organic material having a low dielectric constant, and wherein

bringing said surface treatment gas into contact with said surface of said interlayer insulative film layer such that a diffusion barrier layer is formed comprises bringing said surface treatment gas into contact with said surface of said interlayer insulative film layer such that formed is a diffusion barrier layer of metal or a compound.

Claim 28 (cancelled)

29. (Currently Amended) The method according to claim ~~28~~ 55, wherein

irradiating said diffusion barrier layer with said fast particle beam comprises irradiating said diffusion barrier layer with a particle beam having particle energy in a range of from 200 eV to 10 keV.

Claim 30 (cancelled)

31. (Currently Amended) The method according to claim ~~30~~ 56, wherein

irradiating said surface of said substrate with said fast particle beam comprises irradiating said surface of said substrate with a collimated beam.

32. (Currently Amended) The method according to claim ~~30~~ 56, wherein

bringing said surface treatment gas into contact with said surface of said substrate and irradiating said surface of said substrate with said fast particle beam results in a coating layer being formed in said recess, with dimensions of said coating layer changing during said surface treatment gas being brought into contact with said surface of said substrate and the irradiation of said surface with said fast particle beam such that a depth and a width of said recess also change during said surface treatment gas being brought into contact with said surface of said substrate and the irradiation of said surface with said fast particle beam, and

an aspect ratio, defined by the depth of said recess divided by the width of said recess, remains constant during said surface treatment gas being brought into contact with said surface of said substrate and the irradiation of said surface with said fast particle beam until said coating layer completely fills said recess.

33. (Previously Presented) The method according to claim 21, wherein the surface treatment is anisotropic dry etching of said substrate, and wherein

bringing a surface treatment gas into contact with a surface of a substrate comprises bringing into contact with said surface of said substrate a gas that reacts well with material of said substrate such that a chemical reaction between said material of said substrate and said gas results in a

compound being formed, which compound includes a component element of said material of said substrate, whereby said material of said substrate is removed from said surface of said substrate, and

irradiating said surface of said substrate with a fast particle beam comprises irradiating said surface of said substrate with a collimated beam so as to increase a rate of removal of said material of said substrate along a direction in which said collimated beam is directed toward said surface of said substrate.

34. (Previously Presented) The method according to claim 33, wherein

irradiating said surface of said substrate with a collimated beam comprises irradiating said surface of said substrate with a collimated beam having particle energy in a range of from 200 eV to 10 keV.

35. (Previously Presented) The method according to claim 21, further comprising:

generating said fast particle beam from a gas that is different from said surface treatment gas.

36. (Previously Presented) The method according to claim 35, wherein

bringing a surface treatment gas into contact with a surface of a substrate comprises bringing a non-ionized surface treatment gas into contact with said surface of said substrate.

37. (Previously Presented) The method according to claim 36, wherein

irradiating said surface of said substrate with a fast particle beam comprises irradiating said surface of said substrate with a particle beam selected from the group consisting of a charged particle beam, an atomic beam and a molecular beam.

38. (Previously Presented) The method according to claim 37, wherein the surface treatment is coating of said surface of said substrate, and wherein

irradiating said surface of said substrate with a particle beam selected from the group consisting of a charged particle beam, an atomic beam and a molecular beam comprises irradiating a portion of said surface of said substrate with said particle beam selected from the group consisting

of said charged particle beam, said atomic beam and said molecular beam prior to, simultaneously with, and/or subsequent to bringing said surface treatment gas into contact with said surface of said substrate,

such that bringing said surface treatment gas into contact with said surface of said substrate and irradiating said portion of said surface of said substrate with said particle beam results in component elements of said surface treatment gas being chemically deposited onto said surface of said substrate.

Claim 39 (cancelled)

40. (Previously Presented) The method according to claim 36, wherein the surface treatment is anisotropic dry etching of said substrate, and wherein

bringing a surface treatment gas into contact with a surface of a substrate comprises bringing into contact with said surface of said substrate a gas that reacts well with material of said substrate such that a chemical reaction between said material of said substrate and said gas results in a compound being formed, which compound includes a component element of said material of said substrate, whereby said material of said substrate is removed from said surface of said substrate, and

irradiating said surface of said substrate with a fast particle beam comprises irradiating said surface of said substrate with a collimated beam so as to increase a rate of removal of said material of said substrate along a direction in which said collimated beam is directed toward said surface of said substrate.

41. (Previously Presented) The method according to claim 40, wherein

irradiating said surface of said substrate with a collimated beam comprises irradiating said surface of said substrate with a collimated beam having particle energy in a range of from 200 eV to 10 keV.

42. (Previously Presented) A method of etching a surface of a substrate, comprising:

bringing into contact with a surface of a substrate a gas that reacts well with material of said substrate such that a chemical reaction between said material of said substrate and said gas results in a compound being formed, which compound includes a component element of said material of said substrate, whereby said material of said substrate is removed from said surface of said substrate, and

irradiating said surface of said substrate with an ultraviolet light beam or a laser beam to enhance activity of said surface and/or said gas and thereby increase a rate of removal of said material of said substrate along a direction in which said ultraviolet light beam or said laser beam is directed toward said surface of said substrate.

43. (Previously Presented) The method according to claim 42, wherein

neither said ultraviolet light beam nor said laser beam is formed from said gas.

Claim 44 (cancelled)

45. (Currently Amended) An apparatus for performing a surface treatment on a surface of a substrate, the surface treatment being selected from the group consisting of coating, denaturation, modification and etching, said apparatus comprising:

a reactor housing in which the surface treatment is to be performed;

a first source for supplying a gas into said reactor housing; and

a fast particle beam device for generating a fast particle beam, other than an electron beam and a neutral beam, and directing a generated fast particle beam to a surface of a substrate so as to irradiate the surface with the generated fast particle beam, while bringing the gas into contact with the surface of the substrate, in order to enhance activity of the surface of the substrate and/or the gas and thereby facilitate a reaction between the surface and the gas.

46. (Previously Presented) The apparatus according to claim 45, wherein

said fast particle beam device is for generating a beam selected from the group consisting of an electron beam, a charged particle beam, an atomic beam and a molecular beam.

47. (Previously Presented) The apparatus according to claim 46, further comprising:

a turntable in said reactor housing, said turntable having a receiving surface for receiving the substrate and being rotatable about an axis that is normal to said receiving surface, wherein

said fast particle beam device is for directing a generated fast particle beam to a surface of a substrate by directing the fast particle beam to the surface of the substrate while the substrate is on said receiving surface of said turntable and the surface of the substrate is angled relative to the fast particle beam.

48. (Previously Presented) The apparatus according to claim 45, further comprising:

a second source for supplying a gas into said fast particle beam device, wherein the fast particle beam is to be generated from the gas supplied by said second source, and the gas to be supplied by said second source is different from the gas to be supplied by said first source.

49. (Previously Presented) The apparatus according to claim 48, wherein

said first source is for supplying a non-ionized gas into said reactor housing.

50. (Previously Presented) The apparatus according to claim 49, wherein

said fast particle beam device is for generating a beam selected from the group consisting of an electron beam, a charged particle beam, an atomic beam and a molecular beam.

51. (Previously Presented) The apparatus according to claim 50, further comprising:

a turntable in said reactor housing, said turntable having a receiving surface for receiving the substrate and being rotatable about an axis that is normal to said receiving surface, wherein

said fast particle beam device is for directing a generated fast particle beam to a surface of a substrate by directing the fast particle beam to the surface of the substrate while the substrate is on said receiving surface of said turntable and the surface of the substrate is angled relative to the fast particle beam.

52. (Previously Presented) An apparatus for generating a fast particle beam, comprising:

a housing for receiving a gas; and

anode and cathode plates in said housing and parallel to one another, with each of said anode and cathode plates having a plurality of through holes, and with adjacent ones of said anode and cathode plates being spaced from one another by a distance within a range of from D/14 to D, wherein D is a diameter of said anode and cathode plates,

wherein said adjacent ones of said anode and cathode plates are adapted to be supplied with a high voltage so as to cause a plasma discharge therebetween such that the gas, when received in said housing, becomes ionized.

53. (Previously Presented) The apparatus according to claim 52, wherein said range is from 1 mm to 14 mm.

54. (New) A method of coating a surface of a silicon substrate for fabricating a semiconductor device, with said silicon substrate being provided on said surface with an interconnect pattern recess, said method comprising:

bringing an organic complex gas containing copper as a component element thereof into contact with said surface of said silicon substrate; and

prior to, simultaneously with, and/or subsequent to bringing said organic complex gas into contact with said surface of said silicon substrate, irradiating a portion of said surface of said silicon substrate with a fast particle beam selected from the group consisting of a charged particle beam, an atomic beam and a molecular beam to enhance activity of said surface and/or said organic complex gas so as to facilitate a reaction between said surface and said organic complex gas,

such that bringing said organic complex gas into contact with said surface of said silicon substrate and irradiating said portion of said surface of said silicon substrate with said fast particle beam results in the copper of said organic complex gas being chemically deposited onto said surface of said silicon substrate.

55. (New) A method of coating a surface of a substrate, said substrate including an interlayer insulative film layer as a top layer, and said interlayer insulative film layer defining an interconnect or circuit wiring pattern recess, said method comprising:

bringing a surface treatment gas including component elements into contact with a surface of said interlayer insulative film layer such that a diffusion barrier layer is formed in contact with said interlayer insulative film layer and over a surface of said interconnect or circuit wiring pattern recess so as to define another recess that corresponds to said interconnect or circuit wiring pattern recess;

irradiating said diffusion barrier layer with a fast particle beam, other than an electron beam, to enhance activity of said surface of said interlayer insulative film layer and/or said surface treatment gas so as to facilitate a reaction between said surface and said surface treatment gas and form a strongly combined layer resulting from mixed atoms or molecules of said interlayer insulative film layer and said diffusion barrier layer; and

filling said another recess to form an interconnect of a semiconductor device.

56. (New) A method of coating a surface of a substrate, said surface including a recess, said method comprising:

bringing a surface treatment gas into contact with said surface of said substrate;

irradiating said surface of said substrate with a fast particle beam, other than an electron beam, to enhance activity of said surface and/or said surface treatment gas so as to facilitate a reaction between said surface and said surface treatment gas; and

while irradiating said surface of said substrate with said fast particle beam, changing an angle of said surface relative to said fast particle beam so as to change an angle at which said fast particle beam impinges said surface, whereby said surface in its entirety, including a surface portion defining said recess, is irradiated with said fast particle beam.

57. (New) A method of coating a surface of a silicon substrate for fabricating a semiconductor device, said silicon substrate being provided on a surface thereof with an interconnect pattern recess, said method comprising:

bringing a non-ionized organic complex gas containing copper as a component element thereof into contact with said surface of said silicon substrate;

generating a fast particle beam, selected from the group consisting of a charged particle beam, an atomic beam and a molecular beam, from a gas that is different from said non-ionized organic complex gas; and

prior to, simultaneously with, and/or subsequent to bringing said non-ionized organic complex gas into contact with said surface of said silicon substrate, irradiating a portion of said surface of said silicon substrate with said fast particle beam to enhance activity of said surface and/or said non-ionized organic complex gas so as to facilitate a reaction between said surface and said non-ionized organic complex gas,

such that bringing said non-ionized organic complex gas into contact with said surface of said silicon substrate and irradiating said portion of said surface of said silicon substrate with said fast particle beam results in the copper of said non-ionized organic complex gas being chemically deposited onto said surface of said silicon substrate.

58. (New) A method of etching a surface of a substrate, comprising:

bringing into contact with a surface of a substrate a non-ionized gas that reacts well with material of said substrate such that a chemical reaction between said material of said substrate and said non-ionized gas results in a compound being formed, which compound includes a component element of said material of said substrate, whereby said material of said substrate is removed from said surface of said substrate, and

irradiating said surface of said substrate with an ultraviolet light beam or a laser beam to enhance activity of said surface and/or said non-ionized gas and thereby increase a rate of removal of said material of said substrate along a direction in which said ultraviolet light beam or said laser beam is directed toward said surface of said substrate,

wherein neither said ultraviolet light beam nor said laser beam is formed from said non-ionized gas.